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GEAR CUTTING IN THE DIRECTION OF FEED

M. O. Yakobson, Cand Tech Sci

[Figures are appended.]

Russian Editor's Note: Gear cutting in the direction of feed is being used at present at only a few plants. This method increases productivity and stability of the cutting tool and improves surface finish, especially when machining hard steels. Workers of the machine-building industry should disseminate this method.

The editors consider it very important to solve the following problems: (a) determine the field for applying milling with feed, (b) modernize gear-cutting machines in use and design reliable and simple attachments for elimination of vibration in machine-tool mechanisms, and (c) accelerate output of gear-cutting and milling machines which operate in the direction of feed.

Several years before the war, new mechanisms were built for existing gear-cutting machines which permitted successful development of gear cutting with feed. A number of plants began using machines of all models with similar auxiliary mechanisms. The Pfauter Plant mounted them on Models RS½--RS4 machines which cut gears from 350 to 2,500 millimeters in diameter.

Research showed that parallel (poputnoye) gear cutting is preferred in many ways: the machine operates more quietly, with minimum vibration; cutter stability is increased; the cutting speed, with ample cooling, can be increased; accuracy of gear being cut is increased; and the surface finish of gears is improved.

In conventional gear cutting, the slides which carry the hob move up and down. In parallel gear cutting, four methods are possible in which there is reciprocal travel of gear cutter and blank (see Figure 1).

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Among similar mechanisms used in gear-cutting machines, there is considerable interest in designs shown in Figures 2 and 3.

The first mechanism (Figure 2) consists of two auxiliary nuts, mounted on the lifting screw 1, which turns in a stationary bushing 2 from the worm pair 3 — 4.

The hob 5, together with the support and slide 6, can move up and down along the guides 7 of the headstock. Upon rotation of screw 1, in the direction of arrow I, the slide 6 together with the support moves down in direction of arrow II. In this case, the threads of the screw 1 rest on the lower ridges 8^1 of the threads of nut 8, and between the upper ridges 8^2 of the threads of the nut and the threads of the screw, a gap (zazor) is formed. On the upper part of the lifting screw 1, there is fitted an additional nut 9 with male thread 10. In the lower part of this screw there is a second auxiliary nut consisting of two parts 11 and 12 which are joined by a key (shponkoy) 13. Both of these parts are clamped to the lifting screw with a spring 14. The lower part of the nut 11 is connected by its male thread 15, with the base nut 8. A similar arrangement insures the adjustment of nut 8 to the screw 1 during gear cutting in the direction of feed.

The second mechanism (Figure 3) is a hydraulic device built in in a counterpoise. By means of additional pressure it insures the fitting of the thread profile of the nut to the thread of the screw without a gap during parallel gear cutting. The slide 1 together with the support and hob 2 moves from the bottom upward relative to the work piece 3 with the aid of screw 4. The carrier 1 is connected to the counterpoise 5 which moves inside the headstock. The counterpoise also serves as the cylinder of the hydraulic system of the mechanism. The piston 6 moving in the cylinder 5 is suspended in the headstock. The port 7 in the piston 6 is connected with the pipe 8 along which oil is fed into the system by the pump 9. The throttle valve 10 is connected to the pipe 8. The piston 6 with its port 7 is connected with the reservoir 11, set in the headstock. There is an overflow pipe in the reservoir. Between the reservoir 11 and the pipe 8, there is a slide valve on which the spring 13 acts from one side, and from the other, the electromagnet 14. The switch connected with the electromagnet 14 is interlocked with the starter of the machine. When the cutting begins, the switch 15 is closed and the valve 12, due to the action of the electromagnet, moves to the right, closing the port 7. The oil, going from the pump 9 into the cylinder 11, imparts an additional force to the slide, which moves upward. As a consequence of this action, the upper surfaces of the threads of the nut press against the lifting screw 4. As the up-down speed of the slide and support increases, the electromagnet is disconnected. The spring 13 reactivates the valve 12 to the left, the cylinder 5 connects with the reservoir 11, and the oil leaving the cylinder passes through the overflow pipe 16 of the reservoir. In this case only the counterpoise acts, the hydraulic system being disconnected. Operation is similar during ordinary gear cutting.

The hydraulic system, encountered in Pfauter machines, Models RS$\frac{1}{2}$--RS4, insures a quiet, vibrationless operation of the machine.

Before the war, at the "Komsomolets" Machine-Tool Building Plant, a lifting head of special design was installed on the 5B32 gear-cutting machine. This head, with the aid of bevel gears, eliminated vibration between threads of the feed screw and the nut. Research conducted at the plant laboratories shows that gears obtained with stationary blank and sliding cutter were more accurate than those obtained by the conventional method of gear cutting. Thus, in cutting cast-iron gears of module 4 with 34 teeth, when the feed on one turn of the table is 4 millimeters and the speed of the cutter is 60-83 rpm, the greatest difference in pitch between two adjacent teeth reached 25μ under conventional gear cutting and 15μ under the parallel method. The vibrations, measured on a vibrograph which was fixed on a wooden column set in line with the machine, are presented in Figure 4.

Comparative studies in cutting cycles have shown that with the proposed method of gear cutting from steel, a rate 42-45 meters per minute can be attained.

More precise data on the accuracy of the machines used according to the parallel method are given in the following table.

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Machine Model on Which Gear Cutting Was Done	Dimensions of Gearwheel: Pitch Circle Diameter (mm)	No of Teeth	Module	Cutting Method	Precision of Manufacture of the Wheel (μ): Greatest Difference in Pitch (adjacent teeth)	Difference between Greatest and Smallest Pitch
RS4	1,664	104	16	Against the feed	8	11
RS4	1,664	104	16	With the feed	8	10
RS4	1,710	95	18	" " "	30	35
RS4	1,710	95	18	Against the feed	28	29
RS1 without the counterpoise	143.6	29	4.5	Against the feed	10	17
RS1 with the counterpoise	143.6	29	4.5	Against the feed	8	12
RS1 without the counterpoise	143.6	29	4.5	With the feed	5	12
RS1 with the counterpoise	143.6	29	4.5	" " "	7	8

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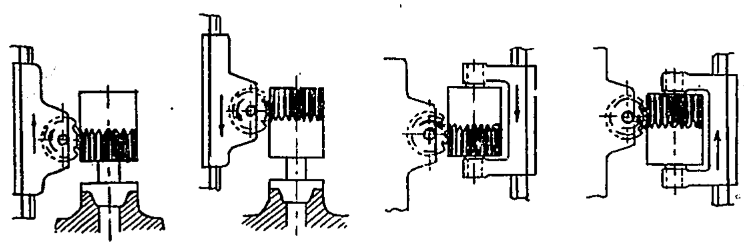

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Figure 1. Four Methods of Parallel Gear Cutting

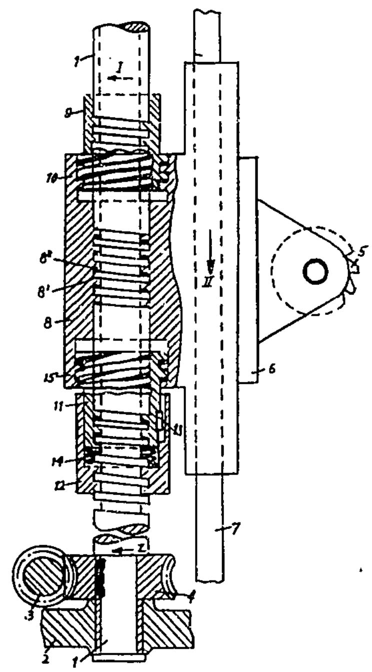

Figure 2. Mechanism for Eliminating Gap between Nut and Lifting Screw

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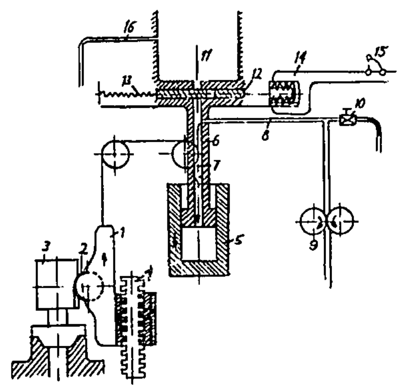

Figure 3. Hydraulic Mechanism for Eliminating Gap

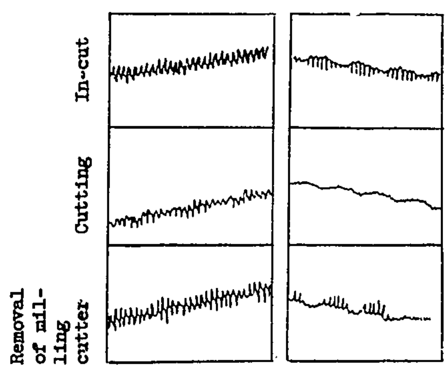

Figure 4. Vibrograph When Cutting Gears with Feed (right) and against Feed (left)

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